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Optimal Protein Intake Across the Adult Lifespan

A Summary of SCAN's 2015 Advanced Practice Protein Summit

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The highlight of the 31st Annual SCAN Symposium in May 2015 was a two-hour presentation and interactive session, *Advanced Practice Protein Summit*, featuring renowned researchers Nancy Rodriguez, PhD, RD, CSSD, FACSM, Harvey Anderson, PhD, and Stuart Phillips, PhD, FACSM, FACN. Each speaker presented scientific evidence clarifying the role of optimal protein intake for well-being across the adult lifespan. In addition, information was provided to translate these data into practical dietary advice for practitioners. Following the presentations, a panel discussion featured questions from the audience and an intellectual exchange on the presentations. Support for this session, which drew nearly 500 attendees, was provided by National Dairy Council, the Beef Checkoff, and the Egg Nutrition Center. This edition of *SCANNERS* discusses the session's highlights.

Issues in Determining Protein Recommendations

The presentations began by reviewing the issues surrounding the Institute of Medicine's Dietary Reference Intakes (DRIs) for protein. DRIs are quantitative recommendations for nutrient intake and include the Recommended Dietary Allowance (RDA), the Estimated Average Requirement (EAR), the Adequate Intake (AI), and the Tolerable Upper Intake (UL).[1] The DRIs for protein were based on nitrogen balance studies under conditions of energy balance.[2] Accordingly, the protein RDA for all adults aged 19 years or older has been set at 0.8 g of high-quality protein/kg body weight. As Wolfe and Miller noted in their commentary in the *Journal of the American Medical Association (JAMA)* in 2008: "… the functional definition of the RDA for protein in the adult is to avoid loss of lean body mass or negative nitrogen balance. Using nitrogen balance to establish adult protein recommendations does not measure any physiological end point."[3]

Use of nitrogen balance to determine adult protein recommendations is singularly focused on the amount of ingested protein necessary to replace the obligatory nitrogen and the total loss of essential amino acids; however, currently there is no identified relationship between nitrogen balance and the numerous other metabolic roles of protein.[3,4] The omission of utilizing clinically and functionally relevant outcomes (such as maintaining muscle protein synthesis and physical function) to determine adult daily protein recommendations is one of the key criticisms of the current approach to establishing protein recommendations, and this fuels the controversy regarding whether the current RDA should be used for designing individual daily meal plans.[4]

The registered dietitian nutritionist (RDN) is faced with providing nutrition education and dietary planning in light of a wide range of protein recommendations that are higher than the RDA and are based on physical activity, maintenance of muscle, and healthy aging. For example, a considerable body of evidence is supportive of 1.0 to 1.2 g of protein/kg body weight as beneficial for healthy aging and to reduce the progression rate of sarcopenia (a generalized loss of skeletal muscle mass with aging); evidence also supports moderately higher levels of dietary protein for physically active individuals.[5-7] The dose-response research regarding protein recommendations associated with increased thermic effect, increased satiety, and attenuation of the lean mass lost during energy restriction are still emerging, but they appear to be in the range of 1.2 to 1.6 g of protein/kg body weight.[8,9] These levels are above the RDA, but well within the Acceptable Macronutrient Distribution Range (AMDR) established within the DRIs as a framework for the upper and lower percent ranges for carbohydrate, fat, and protein recommendations.[1] The protein AMDR is 10% to 35% of total calories, allowing for considerably more flexibility than the RDA in achieving customized individual nutrition and health goals.

Protein Quality Characteristics

The DRIs also indicate that the recommendation of 0.8 g protein/kg body weight should be from high-quality protein, but a definition for this term is not included.[1] Numerous methods to determine dietary protein quality exist, but an updated scoring system called the Digestible Indispensable Amino Acid Score (DIAAS) was recommended by the Food and Agriculture Organizations of the United Nations 2013 report to replace the Protein Digestibility Corrected Amino Acid Score (PDCAAS).[10] The DIAAS system scores protein quality based on digestibility, as well as the quantity and pattern of essential amino acids relative to the amino acid reference pattern (AARP) for humans. DIAAS recognizes the presence of essential amino acids above the AARP. Practically speaking, either system will still score dairy foods, eggs, fish, isolated soy protein, beef, and poultry as "high quality."

Improved assessment of protein digestibility via DIAAS is another tool in differentiating important protein quality characteristics beyond amino acid content and comparison with the AARP that influence the metabolic roles of protein. Specifically, protein digestibility impacts bioavailability and also influences the speed or amino acid rate of appearance (Ra) into plasma. Postprandial amino acid Ra influences whole body protein anabolism and numerous other metabolic responses including the secretion of insulin and glucagon, thus impacting glucose metabolism.[5,6,11] Proteins have been characterized as "fast" or "slow" based on plasma Ra, with whey considered a "fast" protein, rapidly resulting in a pronounced plasma amino acid peak, thus hugely impacting muscle protein synthesis (MPS).[5,6]

The Role of Leucine

Interest in leucine, a branched-chain amino acid, has expanded secondary to a plethora of research demonstrating that leucine activates a key signaling pathway known as mammalian target of rapamycin complex 1 (mTORC1), which is essential to initiate MPS and hence build and maintain muscle mass.[12] MPS, stimulated independently by resistance exercise and postprandial aminoacidemia and synergistically by both, must be greater than muscle protein breakdown for positive protein balance and hence muscle mass maintenance to occur. Impacting the rate of MPS is critical because changing only the breakdown rates will not cause a shift from a catabolic to an anabolic state since released amino acids may be oxidized or transaminated but not necessarily reincorporated into proteins for MPS.[12] Skeletal muscle mass represents approximately 60% of total body protein and plays a central role in whole body protein metabolism by acting as a reservoir supplying amino acids for metabolic functioning.[13,14] Muscle mass, strength, and function play a key role in recovery from trauma, critical illness, maintaining normal glucose metabolism, resting energy expenditure, rate of sarcopenia progression, and independent mobility.[14]

The importance of leucine in MPS is demonstrated by the emergence of a "leucine threshold" or "leucine trigger" concept hypothesizing that a critical quantity of intracellular leucine is necessary to initiate a robust MPS response. Proteins with higher versus lower leucine quantities have more effectiveness in stimulating MPS.[12,15] Furthermore, within 30 minutes following a meal, leucine stimulates the mTORC1 pathway with maximum protein synthesis between 60 to 90 minutes. The leucine threshold value appears to be influenced by age, activity level, and disease presence such as diabetes.[5,15] Because of these observed threshold fluctuations, leucine meal recommendations have varied; however, current consensus appears to be no less than 2.2 g and no more than 3.0 g of leucine per meal.[5,12]

Protein, Leucine, and MPS Interrelationship

Numerous studies have identified the following key concepts regarding the interrelationship of dietary protein, leucine, and MPS in adults:[12]

- Under conditions of energy balance, the quantity of dietary protein ingested daily is critical for metabolic functioning, but equally important is the amount of meal dietary protein to stimulate optimal MPS.

- The quantity of meal dietary protein needed to optimize the skeletal muscle anabolic response appears to be influenced by the leucine content.

- Meals providing protein in greater amounts than necessary for maximal mTORC1 signaling do not provide additional anabolic benefit, but rather result in enhanced amino acid oxidation of the excess protein.

- Older adults appear to have an "anabolic resistance," a term referencing the need to consume a greater amount of essential amino acids to achieve maximal MPS compared with younger adults.

Although the exact amount of ingested protein and leucine to blunt muscle loss and maximally stimulate MPS in older adults is not yet established, it appears that 30 g to 40 g of high-quality protein per meal equivalent to 0.4 g of protein/kg of body weight is necessary.[13,15] Data for younger adults support intake of 20 g to 25 g of high-quality protein per meal, equivalent to 0.25 g protein/kg of body weight.[15]

Translating Research into Practice

The take-away message for the RDN is to create a protein plan that reflects recent evidence-based protein recommendations (per kg of body weight) and also evenly distributes high-quality protein intake at each meal throughout the day. Meeting the recommended protein quantity per meal, particularly the leucine content of that protein, has emerged as an important consideration for dietary planning. Achieving this balanced and sufficient amount of protein per meal has been called the "meal threshold" and is preferable to the typical unbalanced protein intake whereby smaller amounts of dietary protein are consumed at the breakfast and mid-day meals and a greater amount at the evening meal.[13,15] Thus, recommendations for protein intake should be based on individual assessment and health considerations, recognizing the importance of total protein quantity, distribution, timing, and protein quality characteristics.

In addition, the important nutrient contributions of the protein food group and protein's low contribution to total dietary energy intake are factors to appreciate.[16] Data from the National Health and Nutrition Examination Survey (NHANES) 2003 to 2006 and 2007 to 2010 indicate that protein intake in Americans ranges from 14% to 16% of daily energy, on the lower end of the AMDR range. The protein foods group makes significant contributions towards meeting a wide array of nutrient recommendations, including nutrients of concern.[16] A greater proportion of adolescents and older adults do not consume adequate amounts of protein, and these NHANES data show the top calorie sources (percent of total calories) for adults aged 70 years and older are white bread (4.58%), cake, doughnuts, pastries (3.65%), cookies (2.63%), and regular soft drinks

(2.37%), while high-quality protein sources such as beef (1.73%), eggs (1.59%), and low-fat milk (1.59%) are considerably lower.

Regarding concerns about the potential negative health effects of intakes within the AMDR range but above the RDA, it should be recognized that no upper limit (UL) for protein or individual amino acids have been established by the Institute of Medicine.[1] The International Society for Renal Nutrition and Health does recommend protein restriction for individuals with existing kidney disease, but there is no evidence of negative effects on renal function in healthy adults.[12] Bone health and protein is a complex relationship, with a recent review highlighting the positive effect of protein on bone health when calcium intake is adequate and a systematic review stating the evidence was inconclusive for either a positive or negative relationship between bone health and protein intake.[12]

The emergence of considerable data on moderate increases in protein for health promotion and maintenance makes it critical for RDNs to provide dietary planning beyond just meeting the protein RDA. Further investigations will continue to expand our understanding of optimal protein intake because the feeding studies discussed have predominantly used specific protein food sources, rather than examining protein in the context of a complete meal.

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A reproducible client handout appears on the back page.

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Here's What You Need to Know About Protein . . .

Why do we need protein?

Protein is one of the six dietary essential nutrients (protein, carbohydrate, fat, vitamins, minerals, water) necessary for good health. Dietary proteins provide a source of amino acids, including those the body cannot make, called essential amino acids (EAA). The amino acids in protein are considered the building blocks of life because their role in numerous metabolic functions includes building and repairing body tissues as well as maintaining muscle, health, and overall well-being.

Where do we find dietary sources of protein?

The protein food group includes animal (eggs, meat, poultry, seafood, dairy products, cheese, yogurt, whey, milk), and plant (whole grains, beans, peas, nuts, seeds, soy, vegetables) sources. Animal and plant sources both contain EAAs. All animal sources of protein, as well as soy protein, are considered "high-quality protein" according to standardized methods that score protein quality.

How much protein should I eat daily?[1]

Daily protein needs vary according to age, sex, physical activity, and lifestyle factors. Based on recent evidence, the idea that "one protein recommendation fits all adults" may not be the best advice to meet your specific needs. Be sure to consult your physician and registered dietitian for individual guidance (visit www.scandpg.org and www.eatright.org).

The Institute of Medicine has established guidelines for the upper and lower ranges of total daily calories from carbohydrate, fat, and protein. These guidelines are called the Acceptable Macronutrient Distribution Range (AMDR). The AMDR for adults aged 19 years or older is 10% of 35% of total daily calories from protein. Most Americans consume protein at the lower range of the AMDR to meet their basic protein recommendation of 0.4 grams of protein per pound of body weight. Modest increases in intake within the AMDR of 0.5 to 0.9 grams of protein per pound of body weight are recommended for healthy older adults and for those who participate in endurance activities and strength training to maintain body muscle mass and benefit overall health.

Does it matter *when* I eat protein?[2,3]

Dietary protein will best be able to build, repair, and maintain body muscle when it is evenly distributed in meals throughout the day and consumed in balanced amounts. The total amount of dietary protein per meal (assuming 3 meals daily) that you need varies, depending on your age. Young adults should aim for 20 to 25 grams of high-quality protein while middle-aged to older adults should aim for approximately 30 to 40 grams of high-quality protein at each meal (breakfast, lunch, and dinner).

How much protein is equal to 20 grams?

Here are some examples of how you can obtain 20 grams of high-quality protein in your diet:

Food Source and Amount	Calories
Beef, lean: 2.75 ounces	149
Whole egg (3 large eggs)	216
Whey protein isolate: 34 grams	123
Salmon: 2.57 ounces	134
Greek yogurt: 1 cup	163
Kidney beans: 7/8 cup	293

Adapted from USDA Food Composition Tables

1. Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fatty Acids, Protein, Amino Acids. Washington, DC: National Academies Press; 2002.
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